SCHOOL OF PUBLIC HEALTH

COLLEGE OF HEALTH SCIENCES

UNIVERSITY OF GHANA, LEGON

ASSESSMENT OF RESPIRATORY SYMPTOMS AMONG WORKERS AT THE TEMA OIL REFINERY

BY

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THIS DISSERTATION IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF PUBLIC HEALTH (MPH) DEGREE.

JULY, 2015

DECLARATION

I, Ayo-Maria Gregory Olofinkua, declare that except for the other people's investigation which have been duly acknowledged, this work is the result of my own original research and that this dissertation, either in whole or part has not been presented elsewhere for another degree.

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DR. JUDITH STEPHENS **DATE**

(SUPERVISOR)

DEDICATION

This thesis is dedicated to the Almighty God, Arch & Mrs P. O. Olofinkua & Family.

ACKNOWLEDGMENT

I wish to express my sincere gratitude to the Almighty God for His protection I have enjoyed throughout my life, most especially helping me navigate through this programme successfully.

I would like to thank my supervisor Dr Judith Stephens for the necessary support and guidance which propelled me to complete this research. To Prof Julius Fobil (Head of BEOHS department. School of Public Health) and Dr Reginald Quansah, I say thank you very much.

I appreciate immense contribution of my friends and colleagues, most especially, Dr. Cynthia Fonta, Dr. Afua Asabea Amoabeng, Emily Gondwe, Ayomitan Ogunlade, Sulemana Nafisatu, Hotor Dominic Edem for their encouragement and moral support towards my work.

To my dedicated research assistants, Gilles Komi Ametepe, Jerry Sifa Selase, Antwi and loved ones who contributed in diverse ways to my success in this programme, I say a big thank you and may God enrich you with His blessings.

I would want to appreciate the entire staff and management at the Tema Oil Refinery for their support and interest in the research. I would like to express my deep gratitude to Dr. E. Addison and his son Mr. A. K. Addison for their immeasurable support and guidance.

Finally, I am grateful to my family for their prayers, support and inspirations throughout this program of study.

ABSTRACT

Background: The health of workers remains a major global occupational health issue. The relationship between work-related exposures and the health of an individual in a working environment could be an opportunity to assure workers health or be a source of threat to the health and economic wellbeing of a nation. With the increasing rate of industrialization in Ghana, there is the urgent need to investigate and evaluate the health situation of workers at the Tema oil refinery.

Objectives: To determine the prevalence of respiratory symptoms and lung function impairment and associated risk factors.

Methods: A descriptive cross sectional study involving 142 workers was conducted at Tema oil refinery. Quantitative data was obtained from respondents using semi-structured questionnaire to determine socio-demographic factors, occupational and work-related exposure and the prevalence of respiratory symptoms. Their lung function was determined by the use of a spirometer. Data was analysed on STATA version 13.0.

Results: Study participants were predominantly males (99.3%), with one female (0.7%) worker. The prevalence of overall respiratory symptoms was 74.65%, with specific prevalence of cough, itchy ear and throat and to a lesser extent chest tightness shortness of breath and difficulty in breathing at (61.9%), (47.89%), (21.13%), (14.08%) and (18.31%) respectively. About 60.5% of participant's had normal results for the lung function evaluation

Conclusion: The current department and duration of service in the company affects the respiratory system of the participants. The age group of the participants also affects the respiratory system of the participants. The use of personal protective equipment had no effects on respiratory system of participants.

Key words: Respiratory symptoms, Exposure, Lung function,

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LIST OF ACRONYMS

BLS- Bureau of Labor Statistic

BPD- Barrels Per Day

CDU- Crude Distillation Unit

COPD- Chronic Obstructive Pulmonary Disease

EPA- Environmental Protection Agency

EWA- Energy World Africa

FCC - Fluid catalytic cracking

GOLD- Global Initiative for Chronic Obstructive Lung Disease

GHAIP- Ghanaian Italian Petroleum Company

IARC- International Agency for Research on Cancer

IFC- International Finance Corporation

ILO- International Labour Organization

LPG- Liquefied Petroleum Gas

MOP- Movement of Petroleum

NIH- National Institute of Heath

OHSA- Occupational Health and Safety Administration

QCD- Quality Control Department

RFCC- Residue Fluid Catalytic Cracker

TOR- Tema Oil refinery

UKHSE- United Kingdom Health and Safety Executive

VDU- Vacuum distillation unit

WHO- World Health Organization

DEFINITION OF TERMS

Asthma: is a disease affecting the airways that carry air to and from your lungs, usually connected to allergic reaction or other forms of hypersensitivity.

COPD (Chronic Obstructive Pulmonary Disease): is a progressive lung disease that makes it difficult to breathe. Progressive meaning the disease gets worse over time.

Exposure: the state of having no protection from something harmful, e.g. chemicals

Forced vital capacity (FVC): the total volume of air that can be exhaled during a maximal forced expiration effort.

Forced expiratory volume in one second (FEV_1): the volume of air exhaled in the first second under force after a maximal inhalation.

FEV1/ FVC ratio: The percentage of the FVC expired in one second.

Occupational Health is the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations by preventing departures from health, controlling risks and the adaptation of work to people, and people to their jobs.

Pneumonia: is an infection in one or both of the lungs, by germs such as bacteria, viruses, and fungi.

Personal protective equipment: is a specialized clothing or equipment worn by employees for protection against health and safety hazards.

Respiratory symptoms: a medical term used in categorizing common lung and heart conditions, emotions and injuries.

CHAPTER ONE

INTRODUCTION

1.1 Background

The World Health Organisation defines occupational health as the multidisciplinary and comprehensive promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations (World Health Organisation, 1995). This means that all efforts directed at ensuring the health of workers falls within the ambit of occupational health.

A key component of occupational health is the respiratory health of workers, which is especially important for workers in the extractive industries where the risk of contracting respiratory conditions is high (Witter, 2014; Barmbas-Nolen., *et al* 2013). These respiratory conditions will often present as observable respiratory symptoms. Respiratory symptoms are signs indicating the inability of the lungs to exhale air from the lungs which is characterized by chronic obstruction of lung airflow that interferes with normal breathing and is not fully reversible (WHO, 2014).

Respiratory symptoms can also be described as pathological illnesses affecting the organs and tissues that make gas exchange possible in higher organisms. It includes conditions of the upper respiratory tract, trachea, bronchi, bronchioles, alveoli, pleura and pleural cavity, and the nerves and muscles of breathing. It is rated as the second highest common cause of illness recorded amongst oil refinery workers (Tsai *et al*., 2003).

Respiratory symptoms range from mild and self-limiting ones such as the common cold to life-threatening occurrences like pneumonia, pulmonary embolism, and lung cancer (Pandey & Tripathi, 2013). Respiratory symptoms can result from exposure to irritants or toxic chemicals in the environment, and such exposures can immediately present as coughing, phlegm, wheezing, shortness in breath, and difficulty in breathing (Gilmour et al., 2006; Pryor & Pasad, 2008).

Considering that on average, people spend a third (7-9 hours) of their day in the workplace, and many workplaces have significant hazards that workers are exposed to, it figures that workplaces are major sources of toxic respiratory exposures to workers (Lee *et al*., 2007; Rom & Markowitz, 2007). One of such workplaces with important toxic exposures is the oil refinery.

Respiratory symptoms have been found to have a substantial presence in the oil and gas industry, especially in oil refineries (Ezejiofor, 2015). However, most of the respiratory symptoms found in the industry are associated with factors arising from the use and handling of different toxic hazardous chemicals or the lack of adherence to company policies (rules and regulation) on managing hazardous exposures during production processes (Ezejiofor, 2015; WorkSafe, 2013). There are other factors outside the working environment that can cause the symptoms, like the worker's life style or indoor air quality of the workers residence (WHO, 2015).

Research has indicated that many respiratory symptoms among oil workers that results in various respiratory diseases are caused by exposure to air borne particles in the refinery (Delfino, 2005). There is also evidence that these diseases are the major contributors to the mortality, morbidity and disabilities of oil workers in developing countries (Jeebhay & Qulrce, 2007).

A study backed by the WHO states that respiratory conditions account for 24% of the global burden of major occupational diseases and injury risks (Nelson *et al*., 2005). The incidence is rapidly increasing in developing countries such as Ghana and Nigeria (Abdallah *et al*., 2011). However, most African countries lack the urgency to assure the health and wellbeing of workers, and ensure that they are protected from these hazards. This can be due to the lack of effective policies and laws, as well as poor enforcement of available policies. The research into workers safety in Africa is also considered a low priority area (Nuwayhid, 2004). This creates a pressing need for studies in Africa, which would investigate both broad and specific issues pertaining to the state of worker's health.

1.2 Statement of the problem

A substantial part of the global disease burden has some occupational cause (WHO, 2006). Globally, 2.3 million deaths have been attributed to occupation accidents and work-related diseases (International Labour Organisation, 2014). A huge fraction of these deaths has been ascribed to the oil and gas industry, with fatality rate in the industry being 2.5 times higher than the rate in the construction industry, and 7 times higher than other industries (Bureau of Labor Statistic, 2009).

In Ghana, occupational health (OH) data in the oil and gas industry have not been carefully collected and documented, just as there is a paucity of research work on such issues. Ghana also lacks adequate national policies on OH apart from the Factories, Offices and Shops Act 1970, and the Workmen's Compensation Law 1987; it has also not ratified the International Labour Organisation (ILO) conventions focused on OH (Amponsah-Tawiah & Dartey-Baah, 2011). This has led to a failure of public occupational health services emerging in response to the growth of the petroleum industry, coupled with an absence of enforcement capacity of the few regulations on worker's health (Amponsah-Tawiah & Dartey-Baah, 2011).

In addition, despite the efforts of workplace management and co-operation of employees at the Tema oil Refinery in ensuring a healthy work environment, workers are still being exposed to hazards that could result in permanent or temporary diseases. This avoidable exposures, alongside a lack of information on the range of occupational health and safety issues associated with the many hazardous job-roles at TOR, places many workers there at a high risk of having work-induced respiratory symptoms (WHO, 2014).

As such, this study aimed to find out the specific exposures among the sub-group of TOR workers literature identifies as having more hazardous exposures (production staff). It also tried to bridge the knowledge gap in finding the prevalence of respiratory symptoms among the workers resulting from the exposures as well as accessing the range of socio-demographic factors, life style and occupational factors that influence the respiratory symptoms observed among workers at the Tema oil refinery.

1.3 Conceptual frame work

This study used a conceptual framework, as pictured in Figure 1, which explores how different factors interact to result in respiratory symptoms. The socio-demographic factors such as age and gender can influence the prevalence of respiratory symptoms in the working environment, as older worker would be more susceptible to such symptoms, and male workers being more likely to have more exposures to hazards due to the fact that they predominate physically-demanding roles where such exposures are highest. The life style of the worker, which this study delineates as smoking of cigarettes or drinking of alcohol habits, can also result to the manifestation of different respiratory symptoms, as there is a body of literature to assert significant associations between such habits and respiratory deterioration. Factory factors such as the job a worker performs in the refinery can affect the likelihood of the worker having respiratory symptoms. Also, the duration of working service of the individual as well as the use of protective wears and the occupational risk management policies of the company can be predictors of presenting respiratory symptoms. As such, the study will assess how these factors independently influence the respiratory status of the workers.

Relationship between Socio-demographic factors, life style factors and Factory factors, and how they cause respiratory symptoms among worker at the Tema oil refinery.

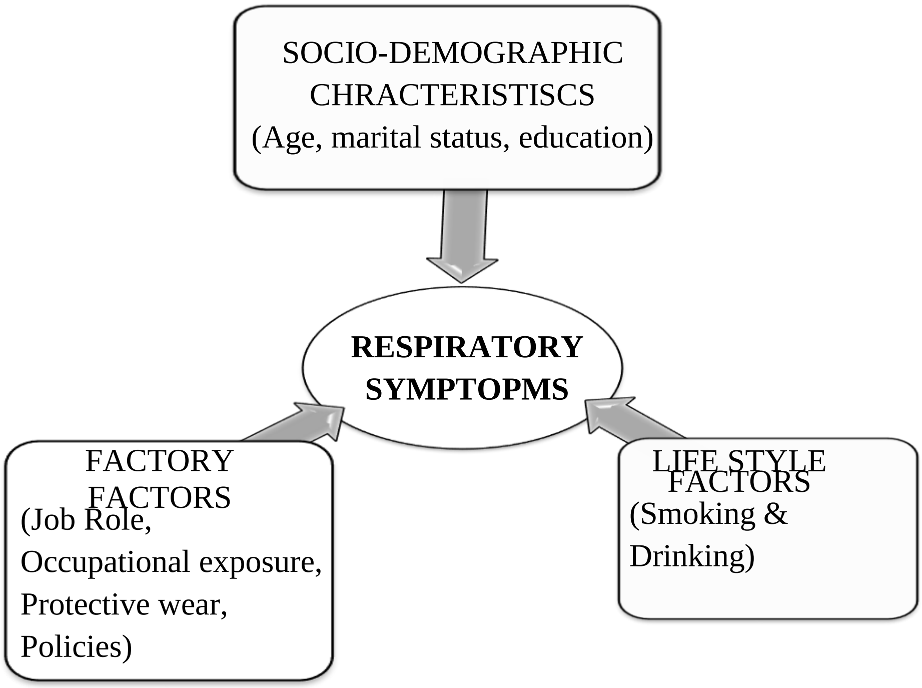

Figure 1: Conceptual Framework of the Study
Source: Author's own conceptual frame work

1.4 Justification

In many developing countries more than 70% of the workers lack a safe and healthy environment, and these nations also neglect the enforcement of occupational health and safety standards (WHO, 2014). A substantial amount of the non-communicable disease burden found in these developing nations (such as: chronic obstructive pulmonary disease, asthma, pneumoconiosis, bronchitis, pulmonary diseases, leukaemia, and back pain) have occupational aetiologies. However, Ghana lacks sufficient data on the impact of workplace hazard on the health of workers especially in its growing oil and gas industry

As such, this study is important in providing needed perspective on the state of worker's health at the Tema Oil refinery, which is a critical unit of the oil and gas industry of Ghana, and hence a vital part of the national economy. It is hoped that findings from this study would guide the development of relevant new policies. It is also expected that the findings would meaningfully contribute to improving current policies, such that it would not only benefit the Ghanaian oil and gas sector, but also serve as a reference for other industrial sectors of the country.

1.5 Limitations

This study did not assess the association between occupational exposures and tested respiratory functions. The exposure reported was considered as not sufficiently large enough to significantly predict respiratory function. The access to medical records was also not available for the research to be able to trace the clinical history of the respiratory health of workers over the period of being a staff of the company.

1.6 Study Objectives

1.6.1 General Objective

To determine the prevalence of respiratory symptoms and lung function impairment and associated risk factors.

1.6.2 Specific Objective

1. To determine the prevalence of respiratory symptoms and indicators of lung function impairment at the Tema oil refinery
2. To determine the association between socio-demographic and life style factors and respiratory symptoms at the Tema oil refinery.
3. To determine the association between social demographic and life style factors and measures of lung function impairment among workers at the Tema oil refinery.
4. To determine the association between the occupational exposure factors and respiratory symptoms among workers at the Tema oil refinery.

CHAPTER TWO

2.0 LITERATURE REVIEW

This chapter seeks to review the literature that are relevant to the study. Literature reviewed was in relation to the historical background of oil discovery and processes, socio-demographic determinant of occupational health, work-related respiratory symptoms, with focus on asthma, COPD, and pneumonia, occupational exposure to irritants and toxic chemicals and finally occupational health and safety of workers. Sources for the literature were journals, books, online articles and newspaper articles obtained from google scholar, Elsevier, HINARI, oxford journals, ScienceDirect OnlineWiley, PUBMED and other data bases.

2.1 Historical Background Information in Petroleum Processes

Since the mid-1840s, crude oil has been used in many parts of Europe and America to light-up streets, make roads, construct buildings etc. The discovery of oil and its use as a viable source of energy for different processes resulted in the industrialisation of various countries around the world. This led to increased commercial and scientific interest in oil exploration in the 19th century.

It is believed that the earliest commercial refining of oil took place in Romania in 1856. This refinery enterprise was funded by huge investments from the United States of America; since then, oil refining has proliferated across the globe. In Africa, oil refining began in 1954 in Algiers, Algeria and Durban, South Africa and refining rapidly spread across the continent leading to the establishment of 52 refineries that produce a total of about 3317 thousand barrels per day (bpd) (Mbendi, 2014) .

The petroleum refining industry produces more than 2500 products from petroleum. These products ranges from fuels such as gasoline to other non-fuel products like paraffin, asphalt, tar and feedstock for the petrochemical industry (Environmental Protection Agency, 1995).

2.2 Crude oil processes

Petroleum refining can be referred to as the separation of crude oil through reactive processes to produce valuable substances (Meyers & Robert, 2003). It is a necessary process because crude oil is a very complex-compound containing thousands of different hydrocarbons and other materials that needs to be separated in order to utilize the components for specialized and varied purposes.

In refining crude oil, there are many processing units that the oil must pass through. The steps in the refinery process include:

The crude oil distillation unit, distils the unprocessed crude into various fractions for processing (Benali, 2010; Meyers, & Robert, 2003; Speight, 1992a). After this the vacuum distillation unit further distils the residue oil from the bottom of the crude oil distillation of other units within the refinery (Benali, 2010; Jones, 1995). Then the catalytic reforming unit converts the desulfurized naphtha molecules into higher-octane molecule to produce reformate (Haydel, 2003). The alkylation unit also converts isobutene and butylene into alkylate, which is a very high-octane component of the end product gasoline or petrol (Speight, 2005b).

In the next step, isomerization unit converts linear molecules such as normal pentane into branched higher octane molecule for blenching into the end product known as gasoline. It is also used to convert linear normal butane into isobutene for use in the alkylation unit (Ebner, O'Neil & Silady, 2002). Afterwards, the distillate hydrotreater unit uses hydrogen to desulfurize some of the other distilled fractions from the crude oil distillation unit (such as diesel) (David & Peter, 2008). Then merox mercaptan oxide desulfurizes liquefied petroleum gas (LPG), kerosene or jet fuel by oxidizing undesired mercaptans to organic disulphide (Jaubert *et al*., 2001).

Amine gas treater, claus unit and tail gas treatment is used for converting hydrogen sulphide gas from the hydrotreaters into end product elemental sulphur. From there fluid catalytic cracking (FCC) unit upgrades the heavier, higher-boiling (700°C-1100°C) fractions from the crude oil distillation by converting them into lighter and lower boiling (510°C-540°C) more valuable products (David & Peter, 2008). The hydrocracker unit also uses hydrogen to upgrade heavier fractions from the crude oil distillation and the vacuum distillation units into lighter more valuable product (Benali, 2010). The visbreaker unit upgrades heavy residual oils from the vacuum distillation unit by thermally cracking them into lighter, more valuable reduced viscosity product. Then delayed coking and fluid coker unit converts very heavy residual oils into end product, petroleum coke as well as naphtha and diesel oil by-product. (Speight, 2005b). The residue fluid catalytic cracking unit converts the high boiling, high-molecular weight hydrocarbon fractions of petroleum crude oils to more valuable gasoline, olefinic gases and other products. (Speight, 2006).

There are other non-core departments that support the final production of petroleum. These support services include the Distribution of Oil/Movement of Oil, Quality Assurance Department and the Marketing Unit.

Distribution of Oil (MOP): The primary method used in the distribution of Petroleum through transmission pipelines to different sector of the refinery. Once at the refinery, crude oil is processed using advance technology like automation, cogeneration and solvent-extraction systems, which help get more out of each barrel of oil processed.

Quality Assurance Department: This involves the laboratory testing of petroleum product. It is concerned with establishing the quality of refinery streams, and in finished and saleable products. The common test carried out to ascertain the quality of finished products cover the following; specific gravity, ASTM distillations, Pensky Marten closed cup flash point, kinematic viscosities, octane numbers, sulphur content tests, liquefied petroleum gas (LPG) weathering tests, Reid vapour pressure and bromine number.

2.3 Socio-demographic factors and individual determinants

The socio-demographic characteristics of employees have influence on the presentation of respiratory symptoms at the place of work.

2.3.1 Gender

The petroleum industry has a much higher constitution of males than females (Randem *et al*., 2004) especially in the production floor of the refinery. This can be due to the fact that males are more physically advantaged to fulfil the energetic duties of production than women. Thus, the mortality and morbidity rates of employees in a study among refinery and petrochemical workers in Louisiana were mainly among males (Tsai *et al*., 2003).

2.3.2 Age

A reasonable portion of the refinery worker's population within 25-65 years of age are found to work in the production area of the refinery (Torén *et al*., 2011). Considering the technicality and physically demanding nature of the work on the production floor of the refinery, Taylor (1996) also asserts that most of the production employees were within 30-59 years of age. In addition, a study among the refinery workers employed in the coking unit of a refinery in Macedonia, indicated that the age range fell within the age range 28-56 years old. They all showed that majority of this age group have high prevalence of respiratory symptoms (Minov *et al*., 2010).

2.3.3 Educational level

The refinery is an automated system which needs highly skilled and trained personnel to keep the system running. The educational level of an employee exposes him/her to a wider scope of information, procedures and interpretation on how to prevent respiratory symptoms. Majority of the refinery workers in the production unit have higher educational level (Minov *et al*., 2010).

2.3.4 Length of Service

The duration or length of service plays a significant role in employee's prevalence to respiratory symptoms. Significant associations have been established between the length of service and developing respiratory symptoms in the refinery environment (Glass *et al*., 1998; Nwibo *et al*., 2012). However a study by Park, Lee & Ryu, (2006) contradicts this findings were there was no significant findings between the length of service and respiratory symptoms.

2.4 Respiratory symptoms in the refinery working environment

The oil refinery process can result to a lot of respiratory symptoms because its environment contains a huge amount of smog and air pollution. All oil refineries in the world are major sources of pollution with the emission of substances like heavy metals, fumes, dust, organic solvents and vapours; all this contribute to the various health and safety hazard related to workers (Park *et al*., 2006). Air pollution affects the respiratory, circulatory and olfactory systems, throughout the refining process, because it is the only main source of entry for the pollutants, resulting in reduced function of the lungs (Al-Jebouri & Al-Doori, 2014).

About 75% of respiratory symptoms of among petroleum refinery workers are caused by air pollutants in the petroleum refinery. This affects workers' productivity rate and the health status of the individual. A work showed that the prevalence of respiratory disease among petroleum employees was second highest among all the diseases investigated among which asthma and chronic bronchitis related factors to exposure at work (Park *et al*., 2006).

In 2013, the International Respiratory Societies (IRS) named chronic obstructive pulmonary disease, asthma, acute respiratory infection, tuberculosis and lung cancer as the top five global burden for respiratory conditions in the world. Globally, over 200 million individuals are reported to have COPD due to occupational gases, excessive smoking of cigarette, in-door smoke and asthma. Asthma divulges an estimate of over 235 million individuals caused either by genetic predisposition (or abnormal immunologic response), occupational and environmental allergens or air pollutants

(Ferkol & Schraufnagel, 2014). Both tuberculosis and lung cancer indicated frequency rate of 8.7 and 1.6 million respectively.

In sub-Saharan Africa, many countries such as Ghana are faced with a paucity of data on respiratory conditions. Although chronic obstructive pulmonary diseases (COPD) seems to be a predominant occupational exposure in past years, there is also an increasing occurrence of asthma in the last few years. There is also a rise in the prevalence of this condition in the Middle East and North of Africa, making it a major public health problem in this countries (Abdallah *et al*., 2011).

2.4.1 Asthma

This is a respiratory condition triggered by allergens like mold, pollen, smoke, strenuous physical activities, exposures to irritating substances that cause the airways to swell and narrow the air passage, resulting in the production of mucous, wheezing, triggering shortness of breath and cough (Balkissoon *et al*., 2011)**.** Refinery workers are potentially exposed to a number of chemicals including toxic particles and gases such as anhydrides, diphenylmethane**,** diisocyanates, acetates, acrylic resins, asbestos, silica, arsenic, hydrocarbon, carbon monoxide, chlorinated inorganic compounds, copper dichlorobenzene (paradichlorobenzene), diesel, dimethyl ether, epoxies hexane (n-hexane), hydrogen sulphide**,** sulphuric acid mist and metals, particularly platinum, zinc, chromium, cadmium and nickel sulphate, chlorine gas, sulphur dioxide and smoke. Exposure to these substances are the major causes of asthma, COPD, pneumonia and lung cancers among refinery workers.

The most recent estimation of asthma around the world suggests that about 334 million people had been diagnosed with asthma as at 2014 (WHO, 2014). This represents an increase in the annual burden of the disease from 2011 when just about 235 million people were estimated to have been suffering from the disease. A sizeable proportion (15%) of all asthma cases are found to be work-related asthma, due to induced or incited substances or conditions in the workplace (Youakim, 2006; Koehoorn *et al*., 2013).

The commonest type of asthma accounting for over 90% of cases is the sensitizer-induced asthma (Tarlo *et al*., 2003) while the less common type called irritant-induced asthma accounts for 7% of cases. The riskiest job position associated with resulting to respiratory conditions are employees working in the Residue Fluid Catalytic Cracking stations, Crude Distillation Unit and Movement of petroleum (Ndubuis Ezejiofor, 2014).

2.4.2 Chronic Obstructive Pulmonary Disease (COPD)

This can be defined as a group of lung diseases characterized by a chronic obstruction of the lung airflow that interferes with the normal breathing and is not easily or fully reversible (WHO, 2015). It could either be termed chronic bronchitis and emphysema, but now they are included under the COPD diagnosis. In most cases the disease occurs in smokers (Balmes *et al*., 2003), but several occupational exposure studies have attributed the cause to work environment (Balmes *et al*., 2003; Hnizdo & Esterhuizen, 2001). Exposure ranging from dust metal, aerosol (fumes, vapour, smoke and mist) can lead to the presenting symptoms like sever cough, production of mucous, shortness of breath, and also wheezing (Baur, 2012).

2.4.3 Pneumonia

Pneumonia is a respiratory infection that usually occur by agitation of the sacs in the lungs, producing phlegm that causes cough, chills, fever and breathing obstruction (Shapiro et al., 2010). It is usually a bacterial infection due to air pollution in the environment of the refinery. Chemicals that can cause pneumonia include; sulphur compounds and nickel. Pneumonia occurs mainly in children (WHO, 2014), but recent studies shows the disease can be caused by exposures to occupational metal fumes, inorganic dust, gases and chemicals (Palmer *et al.*, 2002). Although there are unclear possibilities that this substances increases the risk of infectious pneumonia, Torén *et al.*, (2011) indicated there were strong evidence on the mortality of industrial workers from exposure to inorganic dust and metal fumes. Other recent studies (Toren *et al.*, 2009) also showed dust occupation and occupational exposure to gases, fumes or chemicals were associated to increased risk for infectious pneumonia.

2.5 Occupational and work-related exposure

2.5.1 Respiratory Irritants

Inhaled respiratory irritants can provoke an acute inflammatory response with injury to the epithelial cells of the lungs. Depending on the site of uptake or deposition of the irritant, these effects predominantly involve the upper respiratory tract and airways or the gas exchanging parts of the lungs (ILO, 2011) (Appendix 3). Irritants may be inhaled as gases or vapours, solid particles, or irritating gas and liquid aerosols. In general, water soluble gases and vapours and particles of smooth diameter greater than 5m of irritants are deposited in the upper respiratory tract and proximal airways. Water insoluble gases, vapours and fumes, and particles whose aerodynamic diameter is 0.55m can penetrate into and be deposited or taken up in peripheral airways and the gas exchanging parts of the lung (David *et al*., 2011). The upper respiratory tract is colonized by normal flora, which are regular inhabitants of the surface area and rarely cause disease. The respiratory tract is also a frequent site for infection to occur, due to direct contact with the physical, environmental and exposure to airborne microorganisms (Delfino, 2002). Factors related to the prevalence of respiratory symptoms of workers in a petrochemical complex indicated a significant relationship between work-related factors affecting the respiratory system of workers in the complex (Park *et al*., 2006). Cough was observed to be 1.26 times higher among exposed workers in Great Britain. The prevalence of others symptoms like phlegm, wheezing and shortness of breath also indicated values higher in exposed workers from unexposed workers. Although there are controversies about the sources and effect of irritants to workers a sufficient amount of evidence was collected on the likelihood of some inhaled respiratory irritants to cause chronic airway diseases among the workers (Taylor, 1996).

2.5.2 Toxic Chemicals

Most toxic chemicals that result to injury in the lungs are caused by high levels of exposure. Acids and alkalis can cause upper and lower respiratory tract injuries that can lead to chronic disease. There are various toxic chemicals that can cause significant damage to the parenchymal lung injury despite the moderation of the exposure (Appendix 4). Fritschi *et al*., (2001) conducted a survey amongst workers in three alumina refineries. They were able to observe the presence of alumina dust, caustic mist and bauxite dust and the effect it had in causing respiratory symptoms which could lead to respiratory problems if not properly controlled. Another observation was made by Donoghue *et al*., (2014) of the different risks involved with exposures to the caustic mist and bauxite dust in an alumina refinery. They indicated the report of the occurrence of bauxite dust as the cause chronic pulmonary fibrosis in a man, after the confirmation of an autopsy declaring the presence of bauxite dust within the area of the fibrosis.

Other specific agents like ammonia has been known to cause bronchiectasis among workers in refinery (EPA, 2009), asbestos also is known to cause pulmonary fibrosis of the respiratory system (asbestosis) (NIH, 2011). Appendix 4 shows some toxic chemicals and their source of exposure in the refinery and the resultant health effect on workers.

2.6 Occupational Health and Safety of workers (OHS)

Ghana has experienced some industrial and commercial growth over the past few decades but this growth has not been met with a commensurate improvement in worker safety and health conditions. In other to ensure sustainable growth, assessing workers health should be a major priority, as workers are the backbone of creating a significant industrial base

(Annan, 2014). The main Ghanaian law on worker safety existing is the Factories, Office and Shop Act of 1970 and the Mining Act; however, due to reasons ranging from weak and outdated controls inbuilt in the laws related to enforcement, they have not provided sufficient solutions to tackling OHS problems and protection of the environment. Ghana has also not ratified the ILO rules and regulations on OH (WHO, 2013). Presently, the nation lacks a system of implementing monitoring, evaluating, controlling at preventive measures to exposure among workers. Although a bill is being developed to address this agenda there has been a long delay in passing it while workers continue to be subjected to life threatening conditions daily. The only standing policy is the Mining Act of 1970 with little standard guidelines on OHS. The Radiation Protection Board of the Ghana Atomic Energy Commission is actively and effectively putting in efforts to limit radiation exposures but their impact is limited due to the lack of resources (Bavon, 2000). Currently the oil and gas industry is improving on the handling of hazards and accidents in the environment.

CHAPTER THREE

3.0 METHODS

3.1 Study Design

The study was a descriptive cross-sectional study using quantitative methods.

3.2 Study Area

The study was conducted at Tema Oil Refinery (TOR). Tema Oil Refinery was formerly the Ghanaian-Italian Petroleum (GHAIP) Company and was incorporated as a private limited liability company. It is one of the six largest oil refineries in Africa and the only government owned refinery in Ghana. The company was originally built and owned by Ente Nationalie Indrocarburi (ENI) of Italy in 1963 and later bought by the Ghanaian government in April 1977 which become the sole shareholder of the company. The name was later changed to Tema Oil Refinery (TOR) in 1990. The company is situated 24 kilometres east of the capital, Accra. It has a staff capacity of over 900 workers. In 2000, a Residue Fluid Catalytic Cracking (RFCC) plant was constructed to increase the capacity leading to an increase in workforce. Structurally, the refinery consists of the production plant, crude oil supply area, storage facility, maintenance unit, distribution area and administration building. There are 2 sections in the refinery which are the Production sector and the Administrative sector. However, this study will focus on the Production sector as they are the core production floor departments where the important hazardous exposures are present.

Figure 2. Location of Tema Oil Refinery

Source: Tema, Greater Accra. (17 Jul. 2015). (Google Maps, 2015)

3.3 Variables

Data was collected on the following Variables

Outcome variable:

Respiratory Symptoms: cough, shortness of breath, chest tightness, itchy ears and throat and difficulty in breathing. There was also further investigation into the Lung function Test of participants, for Normal spirometry test (>70% FEV_1/FVC, >80%

FEV_1 and FVC) and abnormal spirometry test (<70% FEV_1/FVC, <80% FEV_1 and FVC).

Independent Variables:

i. **Socio demographic factors:** Age, gender, marital status, educational Level. Current Department, Duration of service,

ii. **Life style factors:** Ever smoked cigarette and Ever drank alcohol.

iii. **Occupational Exposure factors:** such as exposures to Fumes, Dust, Mist, Irritating gas and liquid, Smoke and Heat

Spirometer Measurement

Spirometry examinations were performed according criteria of the American Thoracic Society and European Respiratory Society guideline. A calibrated stadiometer and weighting balance was used to measure participants for the lung function test. The apparatus was calibrated daily and operated within the ambient temperature range of 20°C–25°C. The test was performed with the subject in sitting position using a nose clip. The test was repeated three times after adequate rest and results were obtained in the spirometer. The spirometer readings were expressed as percentages of the predicted values according to current guidelines

3.4 Study population

The study involved the refinery production workers consisting of all workers. The production crew was selected because of their involvement in the daily operation of the plants and close proximity of their offices to the plants.

3.4.1 Inclusion Criteria

Participants with no respiratory condition before recruitment into Tema oil refinery

3.4.1 Exclusion Criteria

Participants with any respiratory condition before recruitment into Tema oil refinery were not allowed to join the study

3.5 Selection of participants

3.5.1 Sample size estimation

The target population of this study was selected based on the review of pre-employment forms of employee from the Human Resources Department. The target population was 190 and the sample size estimation of the study was calculated using (Glenn, 1992) formula.

$$\boldsymbol{n} = \frac{\dfrac{\boldsymbol{P}[\mathbf{1} - \boldsymbol{P}]}{\dfrac{\boldsymbol{A}^2}{\boldsymbol{Z}^2} + \dfrac{\boldsymbol{P}[\mathbf{1} - \boldsymbol{P}]}{\boldsymbol{N}}}}{\boldsymbol{R}}$$

n=sample size required

N=number of people in the population: 190

P=estimated prevalence in the population (0.5)

A=precision desired, expressed as a decimal (5%)

Z=confidence level (95% level of confidence – 1.96)

R= estimated response rate (90%)

$$\boldsymbol{n} = \frac{\dfrac{\mathbf{0.5[1 - 0.5]}}{\dfrac{\mathbf{0.05^2}}{\mathbf{(1.96)^2}} + \dfrac{\mathbf{0.5[1 - 0.5]}}{\mathbf{190}}}}{\mathbf{0.9}}$$

$$\boldsymbol{n} = \frac{\mathbf{127.18115}}{\mathbf{0.9}}$$

$$\boldsymbol{n} = \mathbf{141.3123}$$

Given these parameters the minimum sample size required for this study was computed to be 141. Field work yielded a sample size of 142 participants.

3.5.2 Sampling Technique

Participants were sampled based on the proportions available. TOR has five different departments each constituting a number of people. The distribution of workers by departments is as follows: Quality Control Department (30), Residue Fluid Catalytic Cracking Unit (68), Crude Distillation Unit (42), Treatment of Water (20) and Movement of Petroleum (30). Based on this distribution, the population for each department was divided by the target population and multiplied by the sample size to obtain proportion to be contributed to the sample size. Two of the department's run shifts whilst the others run straight day. Of the departments that ran straight day, a list of all workers in each of the departments was collected and workers were selected by ballot. All those who picked yes were selected and for the study this is a called simple random sampling. The department that ran shifts had 15 workers in a shift was divided by 7 to arrive at 2.14. The list was then taken for the week and a random number between 1 and 2 was selected. The number selected was then used at an interval of two in the list, this is a systematic random sampling. Annex 1 gives a clear illustration of the calculation.

3.6 Data collection method & tools

Structured questionnaires were administered to participants to assess their respiratory symptoms in the company. The questionnaires documented their socio-demographic characteristics, exposure characteristics and lung function evaluation was done using an instrument called a spirometer.

Data was collected from the 18th of May 2015 to 5th of July 2015. The data was collected between hours of 7am to 4pm of each day of the working week of the company.

3.7 Quality control

The research assistants were post-graduate and graduate students from the University of Ghana. They were chosen on the basis of their medical knowledge, previous research experience and fluency in English and additional Ghanaian language (Twi, Ga, Ewi and Fante). They were all given a 1 day training in conducting of the selection interviews, compliance with participant’s confidentiality and privacy needs and administering of questionnaires. The study questionnaire were pretested at the Volta Aluminium Company (VALCO) a steel processing industry in Tema.

The data was collected in an isolated conference room of the company and handled in complete confidence of the participants. All the data sheets were completed and signed by the research investigator. Participants were made to feel comfortable by assuring them of confidentiality and anonymity after which the purpose of the study was explained to them. A spirometer was also used on participants by a trained and qualified doctor.

3.8 Data processing and analysis

A Microsoft Excel spreadsheet was used for the validation of data entries and exported to STATA 13 for analysis. Before analysis began, the data sheet was cross checked to identify errors in the dataset. Any error seen was rectified by referring to the applicable questionnaire to get the correct information. Also, variables were categorised as applicable.

Data analysis was carried out on three levels in other to achieve the objective of the study. The first level of analysis was creating tables showing the socio-demographic distribution of participants as well as the exposures they experience in the course of their work. These are shown in Tables 1 & 2. The results of the respiratory tests performed on participants are also captured using frequencies and proportions in Table 3. A bar chart cited as Figures 3 illustrate the prevalence of respiratory symptoms among participants, by using a composite analysis of combining all responses (Yes &No) together we got the overall response rate

The second level of analysis was to find the chi square associations between variables. Association between respiratory symptom and socio-demographic factors, life style factors as well as occupational exposure factors was captured in Table 3, 4 and 5. The Lung function impairment test was also associated with socio-demographic factors which was shown in Table 6. A p-value of less than 0.05 was set as the significant level for every association investigated in this study.

The third level of analysis was simple and multiple logistic regressions, that were ran to determine the strength of relationship between variables. The simple and multiple regression was ran between the respiratory symptoms and socio-demographic factors as well as exposure factors. In running the regression, the predicator variables were age, current department and duration of service, ever smoke and ever drink. The outcome variable were respiratory symptoms including; cough, shortness of breath, difficulty in breathing, chest tightness and itchy ears and throat. There was also a simple and multiple regression carried out between exposure factors including; heat, dust, smoke, fumes, mist and irritating gas and liquid and the same outcome variables respiratory symptoms, which is shown in Table 8. All predictor variables are binary with responses of Yes and No (No, being the reference category).

3.9 Ethical consideration

Approval was sought from the Ghana Health Service Ethical Committee of the Ministry of Health (Appendix 5). Permission was also sought from Management of the Tema Oil Refinery (Appendix 6). Informed consent was obtained from the participants (Appendix 1).

CHAPTER FOUR

4.0 RESULTS

4.1 Socio-demographic characteristics of study subjects

A total of 142 participants were recruited in this study. Participants were made up of 99.3% (141/142) males and 0.7% (1/142) female. The mean age of participants was 37.1±7.99 years. Majority of the participants 76.76% (109/142) were married while 22.52% (32/142) were single. The level of educational attainment was high among study participants with 81.69% (116/142) of them having tertiary education, while 18.6% (26/142) of participants who had secondary education. Most of the participants 70.42% (100/142) had worked for more than 3 years at Tema oil refinery (TOR), while 29.57% (42/142) of participants had worked less than 3years. The residue fluid catalytic cracking (RFCC) unit provided the largest proportion of participants in this study, with 36.62% (56/142) of participants working there. This was followed by the crude catalytic unit where 21.83% (31/142) of participants worked. Majority of the workers 92.37% (134/142) reported never having smoked cigarettes before; 64.08% (91/142) of the participants have taken alcohol before, of which 36.26% (33/142) have stopped taking alcohol, leaving 63.74% (58/142) still engaging in drinking alcohol. (A summary of the socio-demographic characteristics is shown as Table 1).

Majority of the participants reported having been ever exposed to irritating gas and liquid 92.5% (131/142), heat (83.3%), fumes (86.62%), smoke (67.61%), dust (65.61%) but few were ever exposed to mist (46.66%). Again most of the study participants were currently exposed to irritating gas and liquid (77.46%), fumes (59.86%) but few were exposed to dust (46.48%) and smoke (45.77%). Generally, the table 1 suggests that the workers are exposed to alarmingly high levels of potentially-damaging hazards in the company.

Table 1: Socio-demographic factors, Life style factors and Occupational exposures (ever and current)
*Treatment of water **Quality Control Department; ***Crude distillation unit; ****Movement of product; *****Residue fluid catalytic cracking unit, Igl*-Irritating Gas and Liquid

Variable		Frequency (n=142)		Percentage (100%)
Age (n=142)				
25 – 34 years old		66		46.48
35 – 44 years old		50		35.21
>44 years		26		18.30
Gender (n=142)				
Male		141		99.31
Female		1		0.71
Marital status (n=142)				
Single		32		22.52
Married		109		76.76
Educational level (n=142)				
Secondary		26		18.31
Tertiary		116		81.69
Department (n=142)				
WWT*		15		10.56
QCD**		22		15.49
CDU***		31		21.83
MOP****		22		15.49
RFCC*****		52		36.62
Duration of Service (n=142)				
Less than 3 years		42		29.57
More than 3 years		100		70.42
Ever smoked cigarette (n=142)				
No		134		94.37
Yes		8		5.63
Ever drank alcohol (n=142)				
No		51		35.92
Yes		91		64.08
Ex-drinker of alcohol		33		36.26
Current drinker of alcohol		58		63.74
Occupational exposure	**Ever Exposed**		**Currently Exposed**	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Dust				
No	49	34.51	76	53.52
Yes	93	65.49	66	46.48
Smoke				

No	46	32.39	77	54.23
Yes	96	67.61	65	45.77
Igl*				
No	11	7.75	32	22.54
Yes	131	92.25	110	77.46
Heat				
No	23	16.2	54	38.03
Yes	119	83.8	85	59.86
Fumes				
No	19	13.38	50	35.21
Yes	123	86.62	92	64.79
Mist				
No	80	56.34	87	61.70
Yes	62	43.66	54	38.30

4.2 Lung Function Evaluation

Only 60.5% (86/142) participant's tested normal for both FEV_1/FVC (any score above 70%) and FEV_1 & FVC (any score above 80%). The distribution of participants' test scores based on the American Thoracic Society and European Respiratory Society guidelines is shown in Table 3. The normal range for FEV_1 and FVC individual test score is 80% - 120%. The FEV_1 indicated 28.87% (41/142) of participants tested abnormal (below 80%), while FVC results shows 39.43% (56/142) also had abnormal scores.

Table 2: Results of lung function test of participants in the refinery

FVC* (n=142)	**Frequency (n=142)**	**Percentage (n=100)**
Normal (> 80%)	86	60.56
Abnormal (<80%)		
Mild (70-79%)	25	17.61
Moderate (60-69%)	15	10.56
Severe (< 60%)	16	11.27
FEV_1 (n=142)**	**Frequency (n=142)**	**Percentage (n=100)**
Normal (> 80%)	101	71.13
Abnormal (<80%)		
Mild (70-79%)	24	16.90
Moderate (60-69%)	12	8.45
Severe (< 60%)	5	3.52
FEV_1/FVC (>70%)	142	100.0
FEV_1/FVC, FEV_1 & FVC	86	60.5

*****Forced Vital Capacity ******Forced Expiratory Flow in one seconds

4.3 Prevalence of respiratory symptoms among participants at the Tema oil refinery

The prevalence of respiratory symptoms among participants is presented in Figure 3; the overall prevalence of respiratory symptoms among the participants was 74.65%. The prevalence of other symptoms were; cough (61.97%), itchy ears and throat (47.89%), which happens to occur most of the times in the field of work. The least reported symptom was difficulty in breathing (18.31%), shortness of breath (14.08%) and chest tightness (21.13%). Figure 3 below indicates the prevalence of participants presenting more than one symptoms in the study.

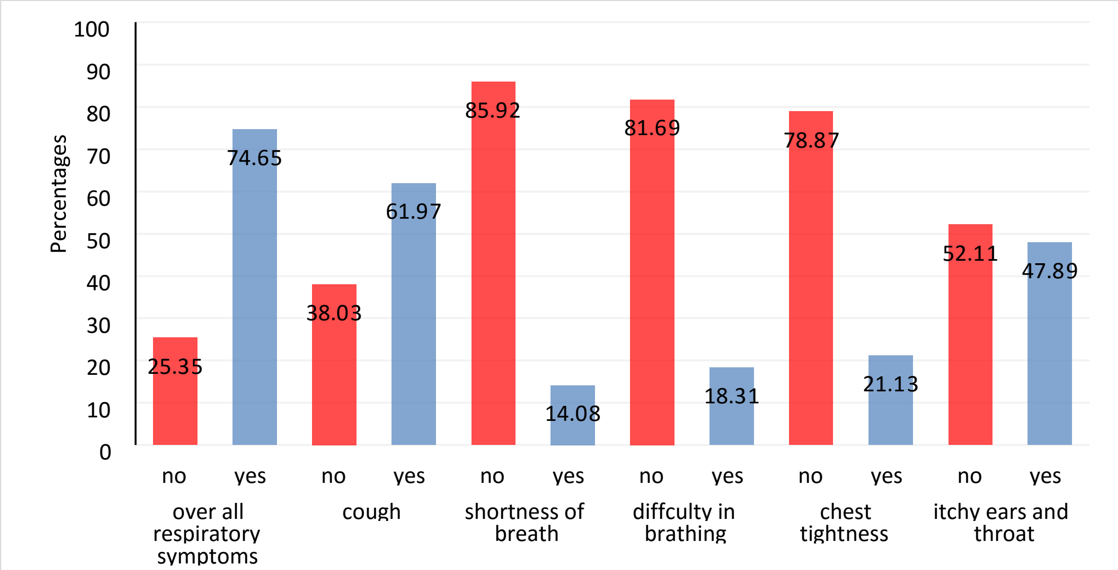

Figure 3: Prevalence of respiratory symptoms among participants at the Tema oil Refinery

4.4 Association between prevalence of respiratory symptoms and socio-demographic factors.

The study indicated significant chi square association between chest tightness (p=0.00), difficulty in breathing (p=0.00), itchy ears and throat (p=0.03) and the department of participants. Participants' duration of service was significantly associated with having cough (p=0.04), itchy ears and throat (p=0.01). There was no association with age, ever smoking of cigarettes and drinking of alcohol and the respiratory symptoms. The results are detailed in Table 3.

Table 3: Association between prevalence of respiratory symptoms and socio-demographic factors.

Variables	Cough			Shortness of breath			Chest tightness			Difficulty in breathing			Itchy ears and throat		
Age	**Yes**	**No**	**χ^2**	**Yes**	**No**	**χ^2**	**Yes**	**No**	**χ^2**	**Yes**	**No**	**χ^2**	**Yes**	**No**	**χ^2**
25-34 years	42(63.4)	24 (36.3)	**6.22 (p=0.36)**	7(10.61)	59(89.2)	**1.32 (p=0.51)**	15(22.7)	51(77.2)	**0.19 (p=0.90)**	15(22.7)	51(77.2)	**2.20 (p=0.33)**	36(54.5)	30(45.4)	**3.07 (p=0.21)**
35-44 years	33(66)	17 (34.0)		9(18.1)	41(82.0)		10(20.0)	40(80.0)		6(12.0)	44(88.0)		23(46.0)	27(54.0)	
>44 years	13(50.0)	13 (50.0)		4(15.38)	22(84.6)		21(80.7)	5(19.2)		5(19.23)	21(80.7)		9(34.6)	17(65.3)	
Current department															
WWT*	11(73.3)	4(26.6)	**7.52 (p=0.48)**	1(6.6)	14(93.3)	**12.34 (p=0.13)**	2(13.3)	13(86.6)	**23.08 (p=0.00)$^{+}$**	2(13.3)	13(86.6)	**23.08 (p=0.00)$^{+}$**	4(26.6)	11(73.3)	**16.77 (p=0.03)$^{+}$**
QCD**	12(54.5)	10(45.4)		3(13.6)	19(86.3)		9(40.9)	13(59.0)		2(9.0)	20(90.9)		8(36.3)	14(63.6)	
CDU***	16(51.6)	15(48.3)		2(6.4)	29(93.5)		3(9.6)	28(90.3)		3(9.6)	28(90.3)		14(45.1)	17(54.8)	
MOP****	14(63.6)	8(36.3)		6(27.2)	16(72.7)		3(13.6)	19(86.6)		5(22.7)	17(77.2)		16(72.7)	6(27.2)	
RFCC****	35(67.3)	17(32.6)		8(15.3)	44(84.9)		13(25.0)	39(75.0)		14(26.9)	38(73.0)		26(50.0)	26(50.0)	
Duration of service															
< 3year	26(48.1)	28(51.8)	**7.06 (p=0.00)$^{+}$**	6(11.1)	48(88.8)	**6.64 (p=0.42)**	7(12.9)	47(87.0)	**3.48 (p=0.06)**	13(24.0)	41(75.9)	**1.93 (p=0.16)**	19(35.1)	35(64.8)	**16.62 (p=0.01)$^{+}$**
>3 years	62(70.4)	26(29.5)		14(15.9)	74(84.0)		23(26.1)	65(73.8)		13(14.7)	75(85.2)		49(55.6)	39(44.3)	
Ever smoked	5(62.5)	83(61.9)	**0.18 (p= 0.91)**	2(25.0)	18(13.4)	**0.92 (p= 0.62)**	2(25.0)	28(20.9)	**0.30 (p=0.86)**	1(12.5)	25(18.6)	**0.33 (p= 0.84)**	4(50.0)	64(47.7)	**0.12 (p= 0.93)**
Ever drank	59(64.8)	29(56.8)	**1.80 (p=0.40)**	15(16.4)	5(9.8)	**1.80 (p= 0.40)**	18(19.7)	12(23.5)	**3.18 (p=0.20)**	17(18.6	9(17.6)	**3.18 (p= 0.20)**	44(48.3	24(47.0)	**3.62 (p=0.16)**

* Treatment of water ** Quality Control Department; *** Crude distillation unit; **** Movement of product; ***** Residue fluid catalytic cracking unit, $^{+}$ (p= 0.05) significant level.

4.5 Association between respiratory symptoms and ever and current occupational exposure.

There was a significant association between cough and participants ever exposed to fumes, heat, irritating gas and liquid ($p< 0.001$), and smoke ($p=0.037$). There was also an association between difficulty in breathing and participants ever exposure to irritating gas and liquid ($p< 0.004$) as well as heat ($p=0.004$) and fumes ($p= 0.024$) exposures. There was a strong association between chest tightness and exposures to irritating gas and liquid ($p= 0.004$) and fumes ($p=0.024$). There was a significant association between itchy ears and throat and participants ever exposed to irritating gas and liquid, fumes ($p<0.001$) and heat ($p=0.005$). Participant's current exposure showed that there was an association between chest tightness and exposure to dust ($p= 0.050$) and smoke ($p=0.018$). There was also association between Itchy ears and throat and exposures to fumes ($p=0.001$). The results are shown both in Table 4 and Table 5.

Table 4: Association between respiratory symptoms and ever exposed to occupational hazard.

Variable	Cough			Shortness of breath			Chest tightness			Difficulty in breathing			Itchy ears and throat		
	Yes	No	χ^2	Yes	No	χ^2	Yes	No	χ^2	Yes	No	χ^2	Yes	No	χ^2
Dust ee[#]	59(63.4)	34(62.9)	1.48 (p=0.47)	12(12.9)	8(16.3)	4.27 (p=0.11)	15(16.1)	15(30.6)	4.74 (p=0.09)	18(19.3)	8(16.3)	3.9611 (p=0.13)	47(50.5)	21(42.8)	4.2732 (p=0.118)
Smoke ee[#]	62(64.5)	26(56.5)	6.60 (p=0.03)[+]	14(14.5)	6(13.0)	4.25 (p=0.11)	19(19.7)	11(23.9)	0.98 (p=0.61)	18(18.7)	8(17.3)	4.2399 (p=0.12)	49(51.0)	19(41.3)	4.9678 (p=0.083)
Igl^ ee[#]	81(61.8)	7(63.6)	38.12 (p<0.00)[+]	19(14.5)	1(9.0)	24.22 (p<0.00)[+]	29(22.1)	1(9.0)	10.82 (p=0.00)[+]	25(19.0)	1(9.0)	24.4564 (p<0.00)[+]	72(54.9)	4(36.36)	24.474 (p<0.001)[+]
Heat ee[#]	77(64.7)	11(47.2)	16.48 (p<0.00)[+]	19(14.5)	6(26.0)	24.2 (p<0.00)[+]	24(20.1)	6(26.0)	4.11 (p=0.12)	23(19.3)	3(13.0)	10.7775 (p=0.00)[+]	57(47.9)	11(47.8)	10.6305 (p=0.005)[+]
Fumes ee[#]	81(65.8)	7(36.8)	22.45 (p<0.00)[+]	17(13.8)	3(15.7)	13.29 (p=0.00)[+]	29(23.5)	1(5.2)	7.43 (p=0.02)[+]	23(18.7)	3(15.7)	7.4327 (p=0.02)[+]	63(51.2)	5(26.3)	15.7498 (p<0.001)[+]
Mist ee[#]	39(62.9)	49(61.2)	2.38 (p=0.30)	8(12.9)	12(15.)	1.74 (p=0.41)	13(20.9)	17(21.2)	0.06 (p=0.96)	13(20.9)	13(16.2)	1.9960 (p=0.36)	33(53.2)	35(43.7)	2.5402 (p= 0.281)

[#] ever exposed ^ Irritating Gas and Liquid, [+] (p= 0.05) significant level

Table 5: Association between respiratory symptoms and currently exposed to occupational hazard.

Variable	Cough			Shortness of breath			Chest tightness			Difficulty in breathing			Itchy ears and throat		
	Yes	No	χ^2	Yes	No	χ^2	Yes	No	χ^2	Yes	No	χ^2	Yes	No	χ^2
Dust ce*	46(69.7)	42(55.6)	4.87 (p=0.08)	9(13.6)	11(14.4)	1.80 (p=0.40)	8(12.1)	22(28.9)	6.00 (p=0.05)[+]	11(16.6)	15(19.7)	2.06 (p=0.35)	31(46.9)	37(48.6)	1.89 (p=0.38)
Smoke ce*	42(64.6)	46(59.7)	0.46 (p=0.79)	10(15.3)	10(12.9)	1.83 (p=0.40)	9(13.8)	21(27.2)	7.99 (p=0.01)[+]	10(15.3)	16(20.7)	2.52 (p=0.28)	36(55.3)	32(41.5)	3.97 (p=0.13)
Igl^ ce*	65(59.0)	23(71.8)	2.22 (p=0.32)	16(14.5)	4(12.5)	0.69 (p=0.70)	25(22.7)	5(15.6)	2.34 (p=0.31)	20(18.1)	6(18.7)	0.59 (p=0.74)	57(51.8)	11(34.3)	3.97 (p=0.13)
Heat ce*	56(65.8)	32(59.2)	8.59 (p=0.07)	12(14.1)	8(14.8)	1.88 (p=0.75)	18(21.1)	12(22.2)	1.22 (p=0.87)	16(18.8)	10(18.5)	2.08 (p=0.72)	42(49.4)	26(48.1)	4.37 (p=0.35)
Fumes ce*	60(65.2)	28(56.0)	3.47 (p=0.17)	12(13.0)	8(16.0)	1.29 (p=0.52)	20(21.7)	10(20.0)	0.42 (p=0.80)	18(19.5)	8(16.0)	1.44 (p=0.48)	54(58.7)	14(28.0)	14.36 (p=0.00)[+]
Mist ce*	32(59.2)	55(63.2)	0.29 (p=0.86)	7(12.9)	13(14.9)	1.40 (p=0.49)	13(24.0)	17(19.5)	2.80 (p=0.24)	11(20.3)	15(17.2)	1.42 (p=0.49)	30(55.5)	37(42.5)	3.18 (p=0.20)

* currently exposed ^ Irritating Gas and Liquid, [+] (p= 0.05) significant level

4.6 Association between socio-demographic factors and Life style factors and lung function impairment

A chi square test was conducted to measure association between the socio-demographic variables, life style variables and lung function indicators (FEV_1, FVC). The result in Table 6 showed that there was no significant association between socio-demographic factors, life style factors and lung function impairment.

Table 6: Association between socio-demographic factors and Life style factors and lung function impairment

	FEV1				**FVC**		
Variables	**Abnormal**	**Normal**	χ^2		**Abnormal**	**Normal**	χ^2
Age							
25-34 years old	18(27.2)	48(72.7)	**0.65**	25-34 years old	24(36.3)	42(63.6)	**0.89**
35-44 years old	15(30.0)	35(70.0)	**(p=0.98)**	35-44 years old	21(42.0)	29(58.0)	**(p=0.92)**
>44 years old	9(17.3)	17(82.7)			12(45.5)	14(54.5)	
Current department							
WWT*	6(40)	9(60.0)	**2.92**	WWT*	8(53.3)	7(46.6)	**2.88**
QCD**	8(36.3)	14(63.6)	**(p=0.57)**	QCD**	9(40.9)	13(59.0)	**(p=0.57)**
CDU***	10(32.2)	21(67.7)		CDU***	10(32.2)	21(67.7)	
MOP****	4(18.1)	18(81.8)		MOP****	7(31.8)	15(68.1)	
RFCC*****	14(26.9	38(73.0)		RFCC*****	23(44.2)	29(55.7)	
Duration of service							
<3 years	17(32.6)	37(67.3)	**0.74**	<3years	23(44.9)	21(56.1)	**1.59**
> 3years	25(28.4)	63(71.5)	**(p=0.76)**	>3years	34(38.6)	54(61.3)	**(p=0.76)**
Ever drank alcohol							
No	15(29.4)	36(70.5)	**0.00**	No	21(41.1)	30(58.8)	**0.03**
Yes	27(29.6)	64(70.3)	**(p=0.97)**	Yes	36 (39.5)	55(60.4)	**(p=0.85)**
Ever smoked cigarettes							
No	36(27.6)	97(72.3)	**4.41**	No	53(39.5)	81(60.4)	**0.34**
Yes	5(62.5)	3(37.5)	**(p=0.03)**	Yes	4(50.0)	4(50.0)	**(p=0.55)**

* Treatment of water ** Quality Control Department; *** Crude distillation unit; **** Movement of product; ***** Residue fluid catalytic cracking unit, $^{+}$ (p= 0.05) significant level

4.7 Relationship between socio-demographic factors, life style factors and respiratory symptoms

Simple and multiple regression analyses, between socio-demographic factors and each of the respiratory symptoms was done. In simple analysis, the odds for chest tightness was 2.4 times higher among participants who had worked for more than 3years compared to those below 3years. The odds for itchy ears and throat was 1.3 times higher among those working in Movement of Petroleum department ($p<0.05$), 2 times more likely to occur among those who had worked for more than 3 years in the company. The odds ratio for difficulty in breathing was 1.4 times greater among participants working at the residue fluid catalytic cracking unit ($p\leq0.05$).

After adjusting for socio-demographic factors, it was found out that cough was 1.3times more likely to occur among participants who had worked for more than 3 years ($p<0.05$). Shortness of breath was also 2.2 times more likely to occur among those in movement of petroleum ($p<0.05$). Chest tightness was 6.3 times more likely to occur also among participants who had worked in the company for more than 3 years (<0.05).

Itchy ears and throats was 1.4 times more likely to occur among participants in Movement of Petroleum and 0.5 times less likely to occur in the age group of participants. Difficulty in breathing had no significant associations with socio-demographic factors. The result are shown in Table 6.

Table 7: Relationship between socio-demographic factors, life style factors and respiratory symptoms among workers at the Tema oil refnery.

Cough	**OR.[a]**	**[95% C.I.][b]**	**pvalue**	**Adj. OR.[d]**	**[95% C.I.][b]**	**pvalue**
Age	0.166	(0.564-1.232)	0.363	0.703	(0.374 -1.320)	0.273
Current department	1.066	(0.835-1.360)	0.132	1.343	(0.909-1.985)	0.138
Duration of service	2.045	(1.125-3.718)	0.623	3.253	(1.364-7.756)	**0.008[e]**
Ever smoke cigarettes	1.024	(0.234-4.468)	0.975	0.228	(0.029-1.764)	0.157
Ever drink alcohol	1.398	(0.693-2.821)	0.349	1.218	(0.488-3.037)	0.672
Shortness of Breath	**OR.[a]**	**[95% C.I.][b]**	**pvalue**	**Adj. OR.[d]**	**[95% C.I.][b]**	**pvalue**
Age	1.307	(0.779-2.192)	0.310	2.319	(0.976-5.507)	0.057
Current department	1.234	(0.858-1.775)	0.257	2.237	(1.220-4.102)	**0.009[e]**
Duration of service	1.607	(0.635-4.066)	0.316	0.656	(0.152-2.833)	0.573
Ever smoke cigarettes	2.148	(0.402-11.47)	0.371	0.396	(0.022-6.907)	0.526
Ever drink alcohol	1.815	(0.618-5.327)	0.277	1.006	(0.225-4.501)	0.993
Chest tightness	**OR.[a]**	**[95% C.I.][b]**	**pvalue**	**Adj. OR.[d]**	**[95% C.I.][b]**	**pvalue**
Age	0.887	(0.548-1.438)	0.629	0.551	(0.223-1.358)	0.196
Current department	1.008	(0.753-1.348)	0.957	1.394	(0.773-2.513)	0.269
Duration of service	2.377	(0.997-5.666)	**0.051[e]**	6.298	(1.100-36.03)	**0.039[e]**
Ever smoke cigarettes	1.261	(0.241-6.594)	0.783	0.939	(0.063-13.95)	0.964
Ever drink alcohol	0.801	(0.350-1.833)	0.600	1.281	(0.365-4.494)	0.698
Itchy ears and throat	**OR.[a]**	**[95% C.I.][b]**	**pvalue**	**Adj. OR.[d]**	**[95% C.I.][b]**	**pvalue**
Age	0.726	(0.489-1.078)	0.113	0.558	(0.297-1.045)	0.057
Current department	1.281	(1.003-1.636)	**0.047[e]**	1.424	(0.980-2.068)	**0.009[e]**
Duration of service	1.968	(1.068-3.624)	**0.030[e]**	4.403	(1.643-11.79)	0.573
Ever smoke cigarettes	1.093	(0.262-4.555)	0.902	1.799	(0.230-14.01)	0.526
Ever drink alcohol	1.053	(0.530-2.092)	0.882	1.187	(0.472-2.980)	0.993
Difficulty in breathing	**OR.[a]**	**[95% C.I.][b]**	**pvalue**	**Adj. OR.[d]**	**[95% C.I.][b]**	**pvalue**
Age	0.762	(0.445-1.303)	0.321	0.849	(0.347-2.076)	0.720
Current department	1.44	(1.017-2.040)	**0.040[e]**	1.702	(1.039-2.790)	**0.035[e]**
Duration of service	0.769	(0.385-1.534)	0.457	0.491	(0.164-1.463)	0.202
Ever smoke cigarettes	0.622	(0.073-5.293)	0.665	0.332	(0.017-6.380)	0.465
Ever drink alcohol	1.072	(0.439-2.616)	0.879	1.238	(0.389-3.943)	0.717

[#]ever exposed, *currently exposed, **personnel protective equipment, ^Irritating gas and liquid, [a]odds ratio, [b]-95% confidence interval, , [d]Adjusted odds ratio, [e]p-value-significant level below 0.05

4.8 Relationship between occupational exposure factors and respiratory symptoms among participants at the Tema oil refinery

The odds ratio (OR) for cough was 3.3 times more likely to occur among participants exposed to fumes ($p<0.05$). The odds ratio for chest tightness was 0.4 times less likely to occur among participants ever exposed to dust and 0.3 times less likely to occur for participants currently exposed to dust, as well as 0.4 less likely to occur among those currently exposed to smoke. The participants who used personnel protective equipment was also 0.2 times less likely to have chest tightness ($p<0.05$). The odds ratio for itchy ears and throat is 3 times more likely to occur among participants ever and currently exposed to fumes respectively. The result is shown in Table 7.

After adjusting for exposure factors, the result in table 7 showed that the odds ratio for cough was 13 times more likely to occur among participants currently exposed to dust currently exposed to dust. Participants were also 0.2 times less likely to have cough when exposed to currently irritating gas and liquid ($p<0.05$). The odds ratio for shortness of breath is 0.01 times less likely to occur among participants using personal protective equipment. The odds ratio for chest tightness and itchy ears and throat was 0.1 times and 0.2 times less likely to occur among participant who made use of the personal protective equipment ($p<0.05$). Difficulty in breathing had no significant relationship with exposure factors.

Table 8: Relationship between occupational exposure and respiratory symptoms among participants in Tema oil refinery.

Cough	**OR.[a]**	**[95% C.I.][b]**	**p-value**	**Adj. OR.[d]**	**[95% C.I.][b]**	**p-value**
Dust ee#	1.196	(0.588-2.431)	0.620	0.412	(0.117-1.440)	0.166
Smoke ee#	1.402	(0.684-2.874)	0.355	0.547	(0.143-2.080)	0.376
Irritating Gas and Liquid ee#	0.925	(0.257-3.322)	0.906	1.011	(0.088-11.614)	0.993
Heat ee#	2.000	(0.812-4.921)	0.131	2.102	(0.435-10.158)	0.355
Fumes ee#	3.306	(1.211-9.021)	**0.020[e]**	1.900	(0.348-10.373)	0.458
Mist ee#	1.072	(0.541-2.125)	0.840	0.527	(0.146-1.896)	0.327
Dust currexp*	1.861	(0.931-3.722)	0.079	13.403	(2.415-74.362)	**0.003[e]**
Smoke currexp*	1.23	(0.621-2.435)	0.551	0.446	(0.097-2.053)	0.301
Igl^ currexp*	0.565	(0.239-1.334)	0.193	0.209	(0.042-1.024)	**0.054[e]**
Heat currexp*	1.203	(0.600-2.411)	0.602	0.990	(0.217-4.511)	0.990
Fumes currexp*	1.473	(0.728-2.979)	0.281	4.116	(0.880-19.243)	0.072
Mist currexp*	0.846	(0.421-1.697)	0.638	0.382	(0.072-2.021)	0.258
Shortness of Breath	**OR.[a]**	**[95% C.I.][b]**	**p-value**	**Adj. OR.[d]**	**[95% C.I.][b]**	**p-value**
Dust ee#	0.759	(0.287-2.003)	0.578	0.21	(0.030-1.448)	0.113
Smoke ee#	1.138	(0.407-3.182)	0.805	2.491	(0.295-21.003)	0.401
Irritating Gas and Liquid ee#	1.696	(0.205-14.02)	0.624	25.103	(0.263-23.938)	0.166
Heat ee#	0.377	(0.127-1.117)	0.079	0.065	(0.003-1.195)	0.066
Fumes ee#	0.855	(0.225-3.250)	0.819	0.311	(0.023-4.157)	0.378
Mist ee#	0.839	(0.320-2.199)	0.722	1.514	(0.150-15.227)	0.725
Dust currexp*	0.933	(0.360-2.412)	0.886	1.342	(0.122-14.670)	0.809
Smoke currexp*	1.218	(0.472-3.138)	0.683	2.108	(0.173-25.577)	0.558
Igl^ currexp*	1.191	(0.368-3.854)	0.770	0.199	(0.009-4.405)	0.307
Heat currexp*	0.907	(0.345-2.386)	0.845	5.033	(0.393-64.341)	0.214
Fumes currexp*	0.787	(0.298-2.076)	0.629	0.367	(0.029-4.656)	0.440
Mist currexp*	0.847	(0.315-2.279)	0.743	2.039	(0.132-31.469)	0.610
Chest tightness	**OR.[a]**	**[95% C.I.][b]**	**p-value**	**Adj. OR.[d]**	**[95% C.I.][b]**	**p-value**
Dust ee#	0.435	(0.191-0.990)	**0.048[e]**	0.356	(0.074-1.710)	0.197
Smoke ee#	0.785	(0.337-1.824)	0.574	1.376	(0.270-7.004)	0.700
Irritating Gas and Liquid ee#	2.843	(0.349-23.13)	0.329	6.220	(0.096-40.393)	0.390
Heat ee#	0.715	(0.254-2.010)	0.526	0.742	(0.109-5.049)	0.761
Fumes ee#	5.553	(0.710-43.40)	0.102	10.558	(0.538-20.057)	0.121
Mist ee#	0.983	(0.436-2.216)	0.967	0.786	(0.125-4.931)	0.798
Dust currexp*	0.338	(0.139-0.824)	**0.017[e]**	0.304	(0.039-2.319)	0.251
Smoke currexp*	0.428	(0.180-1.017)	0.055	0.215	(0.030-1.543)	0.127
Igl^ currexp*	1.588	(0.553-4.553)	0.389	3.398	(0.376-30.659)	0.276
Heat currexp*	0.900	(0.394-2.052)	0.802	1.165	(0.193-7.022)	0.867
Fumes currexp*	1.111	(0.474-2.604)	0.808	0.403	(0.058-2.811)	0.360
Mist currexp*	1.305	(0.575-2.960)	0.523	8.863	(0.842-93.219)	0.069
Itchy ears and throat	**OR.[a]**	**[95% C.I.][b]**	**p-value**	**Adj. OR.[d]**	**[95% C.I.][b]**	**p-value**
Dust ee#	1.362	(0.678-2.734)	0.384	1.801	(0.593-5.471)	0.113
Smoke ee#	1.481	(0.728-3.014)	0.278	1.567	(0.423-5.801)	0.401
Irritating Gas and Liquid ee#	1.671	(0.466-5.984)	0.430	6.483	(0.493-85.177)	0.166
Heat ee#	1.002	(0.410-2.451)	0.995	1.021	(0.189-5.489)	0.066
Fumes ee#	2.940	(0.997-8.662)	**0.050[e]**	0.348	(0.057-2.097)	0.378
Mist ee#	1.463	(0.751-2.848)	0.263	1.140	(0.314-4.137)	0.725

Dust currexp*	0.933	(0.482-1.806)	0.838	0.287	(0.071-1.146)	0.809
Smoke currexp*	1.745	(0.891-3.400)	0.101	1.340	(0.327-5.486)	0.558
Igl^ currexp*	2.053	(0.904-4.660)	0.085	0.889	(0.185-4.263)	0.307
Heat currexp*	0.983	(0.499-1.937)	0.961	0.3170	(0.074-1.356)	0.214
Fumes currexp*	3.654	(1.736-7.688)	**0.001**[e]	5.184	(1.261-21.310)	0.440
Mist currexp*	1.689	(0.851-3.349)	0.133	1.733	(0.387-7.759)	0.610
PPE use**	0.311	(0.113-0.858)	**0.024**[e]	0.284	(0.068-1.182)	**0.000**[e]
Difficulty in breathing	**OR.**[a]	**[95% C.I.]**[b]	**p-value**	**Adj. OR.**[d]	**[95% C.I.]**[b]	**p-value**
Dust ee#	1.230	(0.492-3.073)	0.658	1.123	(0.274-4.605)	0.871
Smoke ee#	1.096	(0.437-2.746)	0.845	1.157	(0.253-5.283)	0.850
Irritating Gas and Liquid ee#	2.358	(0.288-19.28)	0.424	34.884	(1.072-1.135)	0.046
Heat ee#	1.597	(0.437-5.837)	0.479	1.304	(0.156-10.89)	0.806
Fumes ee#	1.277	(0.511-3.188)	0.600	0.172	(0.020-1.441)	0.105
Mist ee#	1.367	(0.582-3.207)	0.472	2.739	(0.539-13.91)	0.224
Dust currexp*	0.813	(0.344-1.920)	0.637	0.804	(0.137-4.715)	0.810
Smoke currexp*	0.693	(0.290-1.654)	0.409	0.283	(0.044-0.789)	0.180
Igl^ currexp*	0.962	(0.350-2.647)	0.942	0.341	(0.044-2.618)	0.301
Heat currexp*	0.977	(0.407-2.344)	0.960	0.607	(0.095-3.869)	0.598
Fumes currexp*	1.277	(0.511-3.188)	0.600	2.824	(0.468-17.02)	0.257
Mist currexp*	1.227	(0.517-2.915)	0.642	1.410	(0.208-9.566)	0.725

#ever exposed, *currently exposed, **personnel protective equipment, ^Irritating gas and liquid, [a]odds ratio, [b]- 95% confidence interval, [a]djust odds ratio, [e]p-value-significant level below 0.05

CHAPTER FIVE

5.0 DISCUSSION

The study results showed significant proportion of the refinery workers are exposed to substances harmful to the respiratory system. Many intermediate by-products during the process of manufacturing, are harmful to workers especially during the primary processing, secondary process and transportation of finished products (IFC, 2007). The sex distribution was male dominated (99.3%) in concordance with a study done in Australia by Fritschi *et al*., (2001), where the participants in the alumina refinery, were predominantly male (68%) because of the sex difference in job specificity (Hnizdo *et al*., 2001). Male predominance (64%) was also found among asphalt workers in Oslo, Norway (Randem *et al*., 2004), and among industrial workers (63%) in Catalonia Spain (Jaén *et al*., 2006). Studies done by Toren and Blanc (2009) also gave a population of men (29.1%) with an increase in respiratory condition. Though the males predominated in the other studies the degree of domination in the study is far greater.

The level of education was high among the participants, and with majority of them having a tertiary degree (81.6%).Similar observations were made in Nigeria (Ezejiofor, 2014)

A high prevalence of respiratory symptoms was found in the study, the overall prevalence of symptoms in the study was 74.65%, which is consistent with a study done among petroleum refinery workers with 33% of overall prevalence of respiratory symptoms (Minov *et al*., 2010). The most common problems were cough (61.9%), itchy ear and throat (47.89%) and to a lesser extent were chest tightness (21.13%), shortness of breath (14.08%) and difficulty in breathing at (18.31%). These results are comparable with previous studies in Iran and Rio de Janeiro, Brazil under similar occupational conditions (Mashallah *et al*., 2006) and (Lemele *et al.*, 1994) with 75% and 41.7% prevalence respectively for irritating cough. The prevalence of chest tightness was also 10.7% (Fritschi *et al*., 2001) and shortness of breath was 10.9% (Randem *et al.*, 2004). It is therefore suggested that the respiratory problems recorded in the present study were associated with exposure to dust, fumes, gases, heat smoke and mist experienced in the refinery.

Although 85% of the participants were found to make use of the personnel protective equipment, the high prevalence of respiratory symptoms suggests that there might be other factors like compliance of workers in making use of this equipment (Nwibo *et al*., 2012). There was significant relationship between prevalence of cough and chest tightness with the duration of exposure. Those who had worked for more than 3 years complained more of the occurrence of the symptoms which is also consistent with Glass *et al*., (1998), but contradicting Parker *et al*., (2006) were their findings indicated the length of service had no significant relationship with respiratory symptoms.

According to Fritschi *et al.*, (2001) most of his findings indicated that there was no reduction in the lung function of both smokers and non-smokers which also supported the present study, in which only 60.5% of participants in the study had normal lung function ($FEV_1/FVC > 70\%$). There was no significant association between participant reduction in FEV_1 value and FVC value for age, departmental duration, and current department, ever drink and ever smoke ($p>0.05$) (Harbison *et al*., 2012). There was also no significant association with exposure to hazards in the refinery ($p>0.05$). Reduction in lung function has however been reported in cotton workers, coal miners, chemical and synthetic workers, grain and flour mill workers, workers exposed to dust, gases fumes, heat and mist (Garshick *et al*., 1996).

The prevalence of five respiratory symptoms was low among smokers and drinker (5.1%), in contrast with Park *et al*., (2006), where the prevalence of respiratory symptoms was high among the participants (56.7%) suggesting smoking and drinking has an important risk factor for developing respiratory symptoms.

During the work process, workers were directly or indirectly exposed to various harmful substances such as acid base and sulphur dioxides. Thus the problem set up for this study was that occupational exposure to these substances would pose health risks by inducing respiratory problems which in the long run can lead to the development out of respiratory conditions. Although the study was not able to diagnose the different types of conditions observed in the refinery because the participants' medical records was not accessible, the study was able to observe the occurrence of five respiratory symptoms pertaining to the refinery from studies (Pascal, 2013).

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

This study sought to assess the factors that influence the respiratory conditions among the production workers in the Residue Fluid Catalytic Cracking Unit, Crude Distillation Unit, Movement of petroleum, Quality Control Department and Water Treatment Unit of the Tema Oil Refinery.

Respiratory symptoms and disease are induced by exposure to fumes, dust, mist, gases and smoke (aldehydes, chlorine oxides, ozone, phosgene and ammonia) irritating the upper and lower airways and lungs, bronchioles and alveoli (GOLD, 2013). Diisocyanates such as toluene diisocyanate (TDI) and methylene diphenyl diisocyanate (MDI) is known to cause occupational asthma. Dust such as silica dust, cadmium, asbestos, coal, nickel, lead and beryllium, are known to cause COPD (Boschetto *et al*., 2006). The prevalence of the five symptoms was significantly high among the workers in production sector of the Tema Oil Refinery exposed to these conditions.

Despite this limitations of the study the prevalence of cough, itchy ear and throat, shortness of breath, chest tightness and difficulty in breathing was 61.9%, 47.9%, 14.1%, 21.13% and 18.01% respectively. The participants were predominantly males (99.3%) and just one female (0.7%) took part in the research. The lung function test conducted on participants showed that only 60.5% participants were able to completely exhale out 70% of the air in their lungs. This means that a good portion of participants have good respiratory system function There are also huge signs of participants working in the Residue Fluid Catalytic cracking Unit and Movement of Petroleum with high prevalence of respiratory symptoms, indicating this could be due to the fact that majority of the activities in the processing plants occurs in this unit.

6.2 Recommendation

Drawing from my findings of the study, the following recommendations are made for consideration and implementation of the health policy-maker, institutions and stakeholders.

1. The respiratory system of workers could be better investigated, by scrutinising further on participants who fall below this limit, (39.4% of participants fall below 70%) with proper in-depth clinical diagnosis.
2. The management of the company could introduce regular rotation of employees from one department to another for reduction of exposure levels.
3. The Occupational Health Department of the Ghana Health Services must also work towards collection of data base or registry for respiratory conditions experienced with in the working environment for proper monitoring and evaluation.
4. Although the company undergoes a periodic medical examination of workers every 2years, there should also be quarterly or yearly tracking of respiratory conditions of workers as a basis for public health advocacy.

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APPENDICES

APPENDIX 1: PARTICIPANT'S CONSENT FORM

RESEARCH TOPIC: ASSESSMENT OF RESPIRATORY CONDITION AMONG WORKERS IN TEMA OIL REFINERY

INTRODUCTION

I am a student from the University of Ghana, School of Public Health. My assistants and I are carrying out a study on assessment of respiratory conditions among workers in Tema oil refinery.

I am very happy to invite you to take part in the study. I would be grateful if you could kindly read this consent or let someone read it to you so that you can decide taking part in the study or not.

STUDY PROCEDURE, ADVANTAGES AND DISCOMFORTS

This study will involve a total 177 respondents who will answer questions about themselves with regard to respiratory conditions. Accepting to take part in this study will take about 20 minutes of your time and we need you to answer the questions. The questions are basically about you and your experiences regarding respiratory conditions. Also, if there are any questions you would rather not answer or that you do not feel comfortable answering, please say so and we will stop the interview or move on to the next question. You will only be required to participate once in this study. Though by taking part in this study, your responses will provide useful information for the improvement of health status of workers and for academic purposes only.

CONFIDENTIALITY

Your participation in this study is voluntary. All the information will be kept confidential and the data will be stored in a locked cabinet. Your name, identity are not needed for the study. However, the information you would provide is going to be identified by a special code number and would be treated strictly as confidential. We assure you that your name shall not appear or be mentioned in any report that might come out from this study. This study will be reviewed and approved by Ghana Health Service Ethical Review Committee (GH-ERC) to make sure that research participants are protected and rights respected. If you have any questions or concerns, please contact Mr. Olofinkua Ayo-Maria Gregory, University of Ghana (0248940962). You can also contact Dr Judith Stephen (0244285224) **or the Ghana Health Service Ethical Review Committee administrator, for further clarification. (Hannah Frimpong, 0243235225 or 0507041223)**

PARTICIPANT'S CONSENT FORM

I have read the foregoing information/ the foregoing information has been read to me or translated to me and I have fully understood it.

I consent voluntarily to participate in this study.

(Name and signature of a witness should be provided in a case where the participant cannot speak or read English)

Name of participant: ____

Signature/thumbprint: _____________________________________

Name of witness: ____

Signature/thumbprint of witness: _____________________________________

Signature of Interviewer: _______________________________________

Date: ___________________________________

APPENDIX 2: QUESTIONNAIRE ON RESPIRATORY CONDITIONS OF WORKERS IN TEMA OIL REFINERY

Section A: General Information

1. Participants ID number…………………………
2. Which year were you born? Year………………………..
3. Please what is your gender? ☐ Male 1 ☐ Female 2
4. What is your current marital status? ☐ Single/Never Married 1 ☐ Married 2

   ☐ Divorced/Separated 3 ☐ Cohabitating 4 ☐ Widowed 5
5. What is your highest level of education?

   ☐ No formal education 1 ☐ Primary 2 ☐ Secondary (JHS/SHS) 3

   ☐ Vocational/Technical School 4 ☐ University 5

Section B: Occupational Information/History

6. Which of these departments do you currently work at in the refinery?

   ☐ RFCC 5 ☐ MOP 4 ☐ CDU 3 ☐ QCD 2 ☐

   WWT 1

   (CDU=Crude distillation Unit, RFCC= Residue Fluid Catalytic Cracking, MOP= Movement of Petroleum, QCD= Quality Control Department and WWT= Treatment of Water.)
7. How long ago were you transferred to your current post?

   ☐ Less than 1 year 1 ☐ 1-2years 2 ☐ 2-3years 3 ☐ more than 3 years 4
8. What other department apart from your current department have you worked at in last 3 years?

☐ RFCC 5 ☐ MOP 4 ☐ CDU 3 ☐ QCD 2 ☐

WWT 1

(CDU=Crude distillation Unit, RFCC= Residue Fluid Catalytic Cracking, MOP= Movement of Petroleum, QCD= Quality Control Department and WWT= Treatment of Water.)

Section C: Occupational/Workplace Safety and Health

9. Has your work ever exposed you to any of the following hazards? Please tick (√) as appropriate **Binary Variables (Yes2 or No1)**

Hazards	Q9.	Q10.
Dust1		
Smoke2		
Irritating Gas and Liquid 3		
Heat 4		
Fumes 5		
Mist 6		
I Don't Know 8		

10. Are you currently exposed to any of the above hazards please indicate in the above dialog box, tick in column Q10 (√)

11. Do you thing the work you do can affect your health in any way? ☐ Yes 1 ☐ No 2 ☐ Don't know 3 11a.

If Yes, please specify

how…………………………………………………………………………………

12. Do you use any personal protective equipment such as respiratory protector when you are working? ☐ Yes 2 No 1 ☐

(If No, skip to question 13)

12a. How often do you wear any personal protective equipment such as respiratory protector when you are working?

☐ Always 3 ☐ Sometimes 2 ☐ Never 1 ☐ Don't know 4

12b. Does the company provide you the personal protective equipment you use, such as the respiratory protector? ☐ Yes 2 ☐ No 1

13. Have you been trained on how to do your work in a healthy and safe environment?

☐ Yes 2 ☐ No 1

<u>Section D: Self-reported Health Status in relation to Occupation</u>

14. In general, how would you rate your health today?

☐ Excellent 5 ☐ Very good 4 ☐ Good 3 ☐ Fair 2 ☐ Poor 1

15. Have you been diagnosed with a respiratory condition?

☐ Yes 2 ☐ No 1 **(If No, skip to 16)**

a. If Yes, what condition?____

(Skip to 18 after answering 15a)

16. Do you have any medical condition (illness) you know about? ☐ Yes 2 ☐ No 1

(If No, skip to 19)

a. What is the medical condition (illness)_________________________________

17. Do you know if it is related to any respiratory condition (illness)? ☐ Yes 2 ☐ No 1

18. Is the condition or its symptoms brought on or made worse by the work you do?

☐ Yes 2 ☐ No 1

19. Do you suffer any of the following during the course of your work? Please Tick(√) as appropriate

Symptoms	Always3	Sometimes2	Never1	Don't know4
Cough				
Itchy ears and throat				
Shortness of breath				
Difficulty in breathing				
Chest tightness				

(If Never is ticked for all symptoms, skip to 20)

20. Do these symptoms stop or reduce in frequency when you are away from your work place? ☐ Yes 2 ☐ No 1

Section E: Lifestyle Information

21. Have you ever smoked cigarettes? ☐ Yes 2 ☐ No 1

(If Yes answer the next question, if No skip to question 22)

21a. Do you currently smoke? ☐ Yes 2 ☐ No 1

(If Yes, skip to 21c; If No, answer the next question)

21b. How long ago did you stop smoking?

☐ <1year 1 ☐ 1-2 years 2 ☐ 2-3 years 3 ☐ >3years 4

21c. For how long have you been smoking/did you smoke?

☐ 1-5years 1 ☐ 6-10years 2 ☐ >10years 3

21d. How many sticks do you smoke/did you smoke per day?

☐ < 5 sticks 1 ☐ < 10 sticks 2 ☐ >10sticks 3

22. Have you ever taken alcohol? ☐ Yes 2 ☐ No 1
(If No, end interview)

22a. Do you currently take alcohol? ☐ Yes 2 ☐ No 1

(If Yes, skip to 21c; If No, answer the next question)

22b. How long ago did you stop taking alcohol?

☐ <1year 1 ☐ 1-2 years 2 ☐ 2-3 years 4 ☐ > 3years 5`

22c. For how long have you been taking alcohol/did you take alcohol?

☐ 1-5 years 1 ☐ 6-10years 2 ☐ >10years 3

22d. Which type of alcohol do/did you usually take? Please Tick (√) as appropriate

(Binary variables)	Yes 2	No 1
Spirits 1		
Bitters 2		
Beers 3		
Other 4		

22e. How much alcohol do/did you take per day? ☐ <5tots 1 ☐ 5-10tots 2

☐ >10tots 3

Thank you for your participation in this study. This research will help us know better the respiratory health problems associated with your work and how best to eliminate or prevent them. Your participation is very much appreciated.

Height:________cms Weight:__________kgs Age: ________ yrs

Spirometry Results

FEV1: _______________

FVC: ________________ Overall Result:_____________

APPENDIX 3: SUMMARY OF TOXIC CHEMICALS, SOURCE AND INJURY PRODUCED TO WORKERS

Compound	Sources of exposure	Injury produced
Acrolein	combustion products	Diffuse airway and parenchymal injury
Antimony trichloride; Antimony pentachloride	Alloys, organic catalysts Inhibitor (isomerization)	Pneumonitis, non-cardiogenic pulmonary oedema
Cadmium and Platinum	Alloys, (Catalytic reforming) isomerization, hydrotreating	Tracheobronchitis, pulmonary oedema (often delayed onset over 24–48 hours), kidney damage: tubule proteinuria
Chloropicrin	Chemical manufacturing	Upper and lower airway inflammation
Chlorine	Rejuvenation of platinum catalyst, cooling water treatment	Upper and lower airway inflammation, pneumonitis and non-cardiogenic pulmonary oedema
Hydrogen sulphide	Atmospheric distillation, catalytic cracking and reforming, hydrocracking, hydrotreating, sulphur recovery, residual processing, lubricant oil processing and waste water	Ocular, upper and lower airway irritation, delayed pulmonary oedema, asphyxiation from systemic tissue hypoxia
Lithium hydride	Alloys, chemical catalysts	Pneumonitis, non-cardiogenic pulmonary oedema
Methyl isocyanate	Pesticide synthesis	Upper and lower respiratory tract irritation, pulmonary oedema
Mercury	Electrolysis, ore and amalgam extraction, electronics manufacture	Ocular and respiratory tract inflammation, pneumonitis, CNS, kidney and systemic effects
Nickel carbonyl	Nickel refining, electroplating, chemical reagents	Lower respiratory irritation, pneumonitis, delayed systemic toxic effects
Nitrogen dioxide and Sulfur oxides	combustion products (flares and furnace)	Ocular and upper airway inflammation, non-cardiogenic pulmonary oedema, delayed onset bronchiolitis
Nitrogen mustards, sulphur mustards	Military agents, vesicants	Ocular and respiratory tract inflammation, pneumonitis
		Selective damage to type-2 pneumocytes leading to RADS, pulmonary fibrosis; renal failure, GI irritation
Phosgene	Catalyst rejuvenation by chlorination catalytic reforming	Upper airway inflammation and pneumonitis; delayed pulmonary oedema in low doses
Zinc chloride	Smoke, artillery	Upper and lower airway irritation, fever, delayed onset pneumonitis

APPENDIX 4: SUMMARY OF RESPIRATORY IRRITANT AND INJURY PRODUCED TO WORKERS

Chemical	Important properties	Injury produced
Acetaldehyde	High vapour pressure; high water solubility	Upper airway injury; rarely causes delayed pulmonary oedema
Acetic acid, organic acids	Water soluble	Ocular and upper airway injury
Acid anhydrides	Water soluble, highly reactive, may cause allergic sensitization	Ocular, upper airway injury, bronchospasm; pulmonary haemorrhage after massive exposure
Acrolein	High vapour pressure, intermediate water solubility, extremely irritating	Diffuse airway and parenchymal injury
Ammonia	Alkaline gas, very high water solubility	Primarily ocular and upper airway burn; massive exposure may cause bronchiectasis
Antimony trichloride, antimony penta-chloride	Poorly soluble, injury likely due to halide ion	Pneumonitis, non-cardiogenic pulmonary oedema
Beryllium	Irritant metal, also acts as an antigen to promote a long-term granulomatous response	Acute upper airway injury, tracheobronchitis, chemical pneumonitis
Boranes (diborane)	Water soluble gas	Upper airway injury, pneumonitis with massive exposure
Hydrogen bromide		Upper airway injury, pneumonitis with massive exposure
Methyl bromide	Moderately soluble gas	Upper and lower airway injury, pneumonitis, CNS depression and seizures
Cadmium	Acute and chronic respiratory effects	Tracheobronchitis, pulmonary oedema (often delayed onset over 24–48 hours); chronic low level exposure leads to inflammatory changes and emphysema
Calcium oxide, calcium hydroxide	Moderately caustic, very high doses required for toxicity	Upper and lower airway inflammation, pneumonitis
Chlorine	Intermediate water solubilty	Upper and lower airway inflammation, pneumonitis and non-cardiogenic pulmonary oedema
Chloroacetophenone	Irritant qualities are used to incapacitate; alkylating agent	Ocular and upper airway inflammation, lower airway and parenchymal injury with 63esican exposure
***o*-Chlorobenzomalo-nitrile**	Irritant qualities are used to incapacitate	Ocular and upper airway inflammation, lower airway injury with massive exposure
Chloromethyl ethers		Upper and lower airway irritation, also a respiratory tract carcinogen
Chloropicrin	Former First World War gas	Upper and lower airway inflammation
Chromic acid (Cr(IV))	Water soluble irritant, allergic sensitizer	Nasal inflammation and ulceration, rhinitis, pneumonitis with massive exposure

Cobalt	Non-specific irritant, also allergic sensitizer	Acute bronchospasm and/or pneumonitis; chronic exposure can cause lung fibrosis
Formaldehyde	Highly water soluble, rapidly metabolized; primarily acts via sensory nerve stimulation; sensitization reported	Ocular and upper airway irritation; bronchospasm in severe exposure; contact dermatitis in sensitized persons
Hydrochloric acid	Highly water soluble	Ocular and upper airway inflammation, lower airway inflammation only with massive exposure
Hydrofluoric acid	Highly water soluble, powerful and rapid oxidant, lowers serum calcium in massive exposure	Ocular and upper airway inflammation, tracheobronchitis and pneumonitis with massive exposure
Isocyanates	Low molecular weight organic compounds, irritants, cause sensitization in susceptible persons	Ocular, upper and lower inflammation; asthma, hypersensitivity pneumonitis in sensitized persons
Lithium hydride	Low solubility, highly reactive	Pneumonitis, non-cardiogenic pulmonary oedema
Mercury	No respiratory symptoms with low level, chronic exposure	Ocular and respiratory tract inflammation, pneumonitis, CNS, kidney and systemic effects
Nickel carbonyl	Potent toxin	Lower respiratory irritation, pneumonitis, delayed systemic toxic effects
Nitrogen dioxide	Low water solubility, brown gas at high concentration	Ocular and upper airway inflammation, non-cardiogenic pulmonary oedema, delayed onset bronchiolitis
Nitrogen mustards; sulphur mustards	Causes severe injury, vesicant properties	Ocular, upper and lower airway inflammation, pneumonitis
Osmium tetroxide	Metallic osmium is inert, tetraoxide forms when heated in air	Severe ocular and upper airway irritation; transient renal damage
Ozone	Sweet smelling gas, moderate water solubility	Upper and lower airway inflammation; asthmatics more susceptible
Phosgene	Poorly water soluble, does not irritate airways in low doses	Upper airway inflammation and pneumonitis; delayed pulmonary oedema in low doses
Phosphoric sulphides		Ocular and upper airway inflammation
Phosphoric chlorides	Form phosphoric acid and hydrochloric acid on contact with mucosal surfaces	Ocular and upper airway inflammation
Selenium dioxide	Strong 64esicant, forms selenious acid (H^2SeO^3) on mucosal surfaces	Ocular and upper airway inflammation, pulmonary oedema in massive exposure
Hydrogen selenide	Water soluble; exposure to selenium compounds gives rise to garlic odour breath	Ocular and upper airway inflammation, delayed pulmonary oedema
Styrene	Highly irritating	Ocular, upper and lower airway inflammation, neurological impairments

Sulphur dioxide	Highly water soluble gas	Upper airway inflammation, bronchoconstriction, pneumonitis on massive exposure
Titanium tetrachloride	Chloride ions form HCl on mucosa	Upper airway injury
Uranium hexafluoride	Toxicity likely from chloride ions	Upper and lower airway injury, bronchospasm, pneumonitis
Vanadium pentoxide		Ocular, upper and lower airway symptoms
Zinc chloride	More severe than zinc oxide exposure	Upper and lower airway irritation, fever, delayed onset pneumonitis
Zirconium tetrachloride	Chloride ion toxicity	Upper and lower airway irritation, pneumonitis

Source: The International Labor Organization, Geneva, 2011.

APPENDIX 5: GHANA HEALTH SERVICE REVIEW COMMITTEE, ETHICAL APPROVAL

GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

In case of reply the number and date of this Letter should be quoted.

My Ref. :GHS-ERC: 3
Your Ref. No.

Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
Tel: +233-302-681109
Fax + 233-302-685424
Email: Hannah.Frimpong@ghsmail.org

29th May, 2015

Olofinkua Gregory Ayo-Maria
School of Public Health
University of Ghana
Legon, Accra

ETHICS APPROVAL - ID NO: GHS-ERC: 30/02/15

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol titled:

"Assessment of Respiratory Conditions among Workers in Tema Oil Refinery"

This approval requires that you inform the Ethics Review Committee (ERC) when the study begins and provide Mid-term reports of the study to the Ethics Review Committee (ERC) for continuous review. The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Please note that any modification without ERC approval is rendered invalid.

You are also required to report all serious adverse events related to this study to the ERC within seven days verbally and fourteen days in writing.

You are requested to submit a final report on the study to assure the ERC that the project was implemented as per approved protocol. You are also to inform the ERC and your sponsor before any publication of the research findings.

1

Please note that this approval is given for a period of 12 months, beginning May 29th 2015 to 28th May 2016.

However, you are required to request for renewal of your study if it lasts for more than 12 months.

Please always quote the protocol identification number in all future correspondence in relation to this approved protocol

SIGNED..

DR. CYNTHIA BANNERMAN
(GHS-ERC CHAIRPERSON)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra

APPENDIX 6: APPROVAL OF RESEARCH WORK FROM THE SITE OF STUDY

Tema Oil Refinery (TOR) Ltd.

Post Office Box CO599
Tema, Ghana
Tel: +233 (0)30 330 4096-7, 330 2882-3
Fax: +233 (0)30 330 2910, 330 3989
E-mail: tor@torghana.com
Website: www.torghana.com

HS/RA.1/15

27th May, 2015

Head of Department

Department of Biological, Environmental and Occupational Health Sciences

School of Public Health

College of Health Sciences

University of Ghana

Dear Sir,

ASSESSMENT OF RESPIRATORY CONDITIONS AMONG WORKERS IN TEMA OIL REFINERY – SUPPORT AND ETHICAL APPROVAL

We have evaluated the above research proposal and do confirm that the aims, objectives and methodology are consistent with our company's ethical requirements. Notably, the consent of the study population and confidential handling of data have been emphasized to the student.

In addition, the student is expected to meet other requirements before, during and after collection of data, which include review of the questionnaire to reduce information bias, single-use mouthpiece for spirometry, and submission of a copy of the final research report to the company.

Approval has provisionally been given for relevant data to be collected only for the purpose of this research.

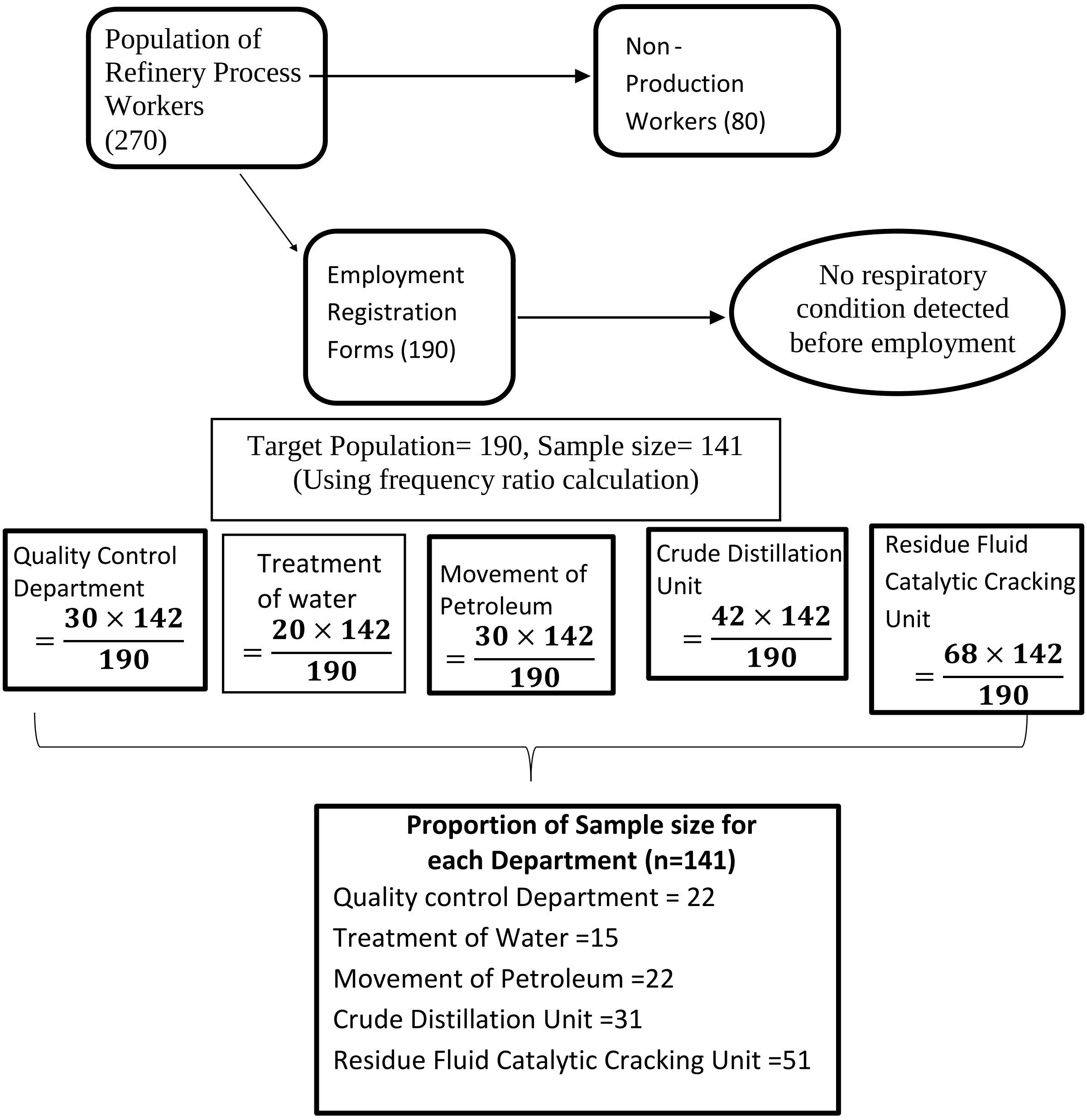
Yours faithfully,

Dr. Lord K. Arhinkorah

[MB ChB (UGMS), MSc Occupational Health (UoB, UK), Grad. IOSH]

Acting Chief Medical Officer

ANNEX 1: INFORMATION FROM THE HUMAN RESOURCE DEPARTMENT



Flow charts on selection of participants